Landscape trees & climate change: selection and management

Igor Laćan
Urban Forestry Advisor
UCCE San Mateo/San Francisco

With slides from

Dr. **Larry Costello**
UCCE emeritus

Dr. **Joe McBride**
Professor, UCB

Drs. **Oki** and **Fujino**
UC Davis

ilacan@ucanr.edu
510 684 4323

UC CE
University of California
Agriculture and Natural Resources
Cooperative Extension

outline

We are discussing ornamental trees in residential landscapes;
NOT wildlands forests, timber plantations, agriculture, orchards!

1. *Street trees & climate change study: what we learned from space-for-time substitution*
2. *…what do the study results suggest for individual landscapes*
3. *…and how to establish your trees and maintain them during the drought*

basic ideas

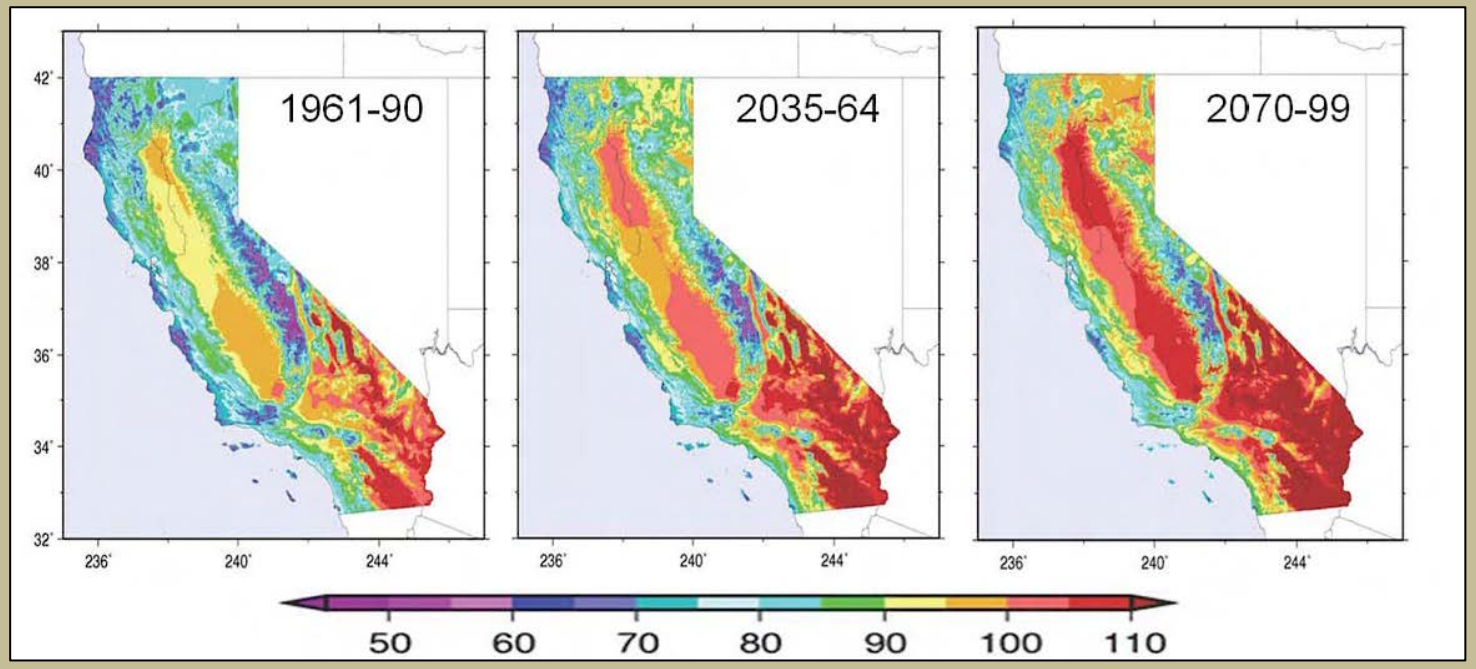
warmer climate = challenge to trees and to management		*but we still will be able to grow trees*
mortality is unfortunate but normal		*not an excuse for not (re)planting!*
manage the factor(s) in tree loss (those that you can manage)		*species selection? site conditions? management?*
droughts will recur, perhaps more frequently		*help your trees survive!*

outline

We are discussing ornamental trees in residential landscapes;
NOT wildlands forests, timber plantations, agriculture, orchards!

1. *Street trees & climate change study: what we can learn from space-for-time substitution*
2. *…what do the study results suggest for individual landscapes*
3. *…and how to establish your trees and maintain them during the drought*

Temperature Patterns & Planning for the Future:
Street Trees and California's Changing Climate



Joe R. McBride and Igor Lacan

Department of Landscape Architecture and Environmental Planning

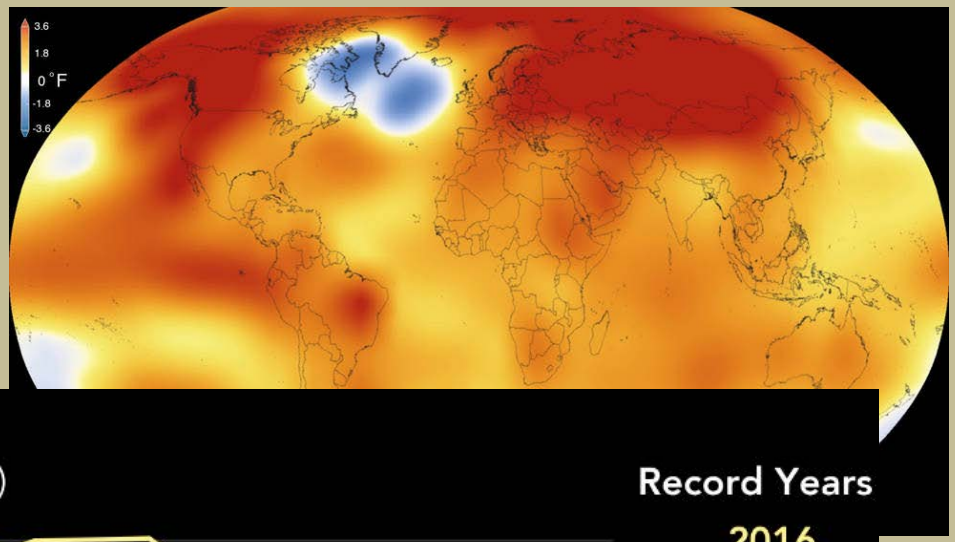
and

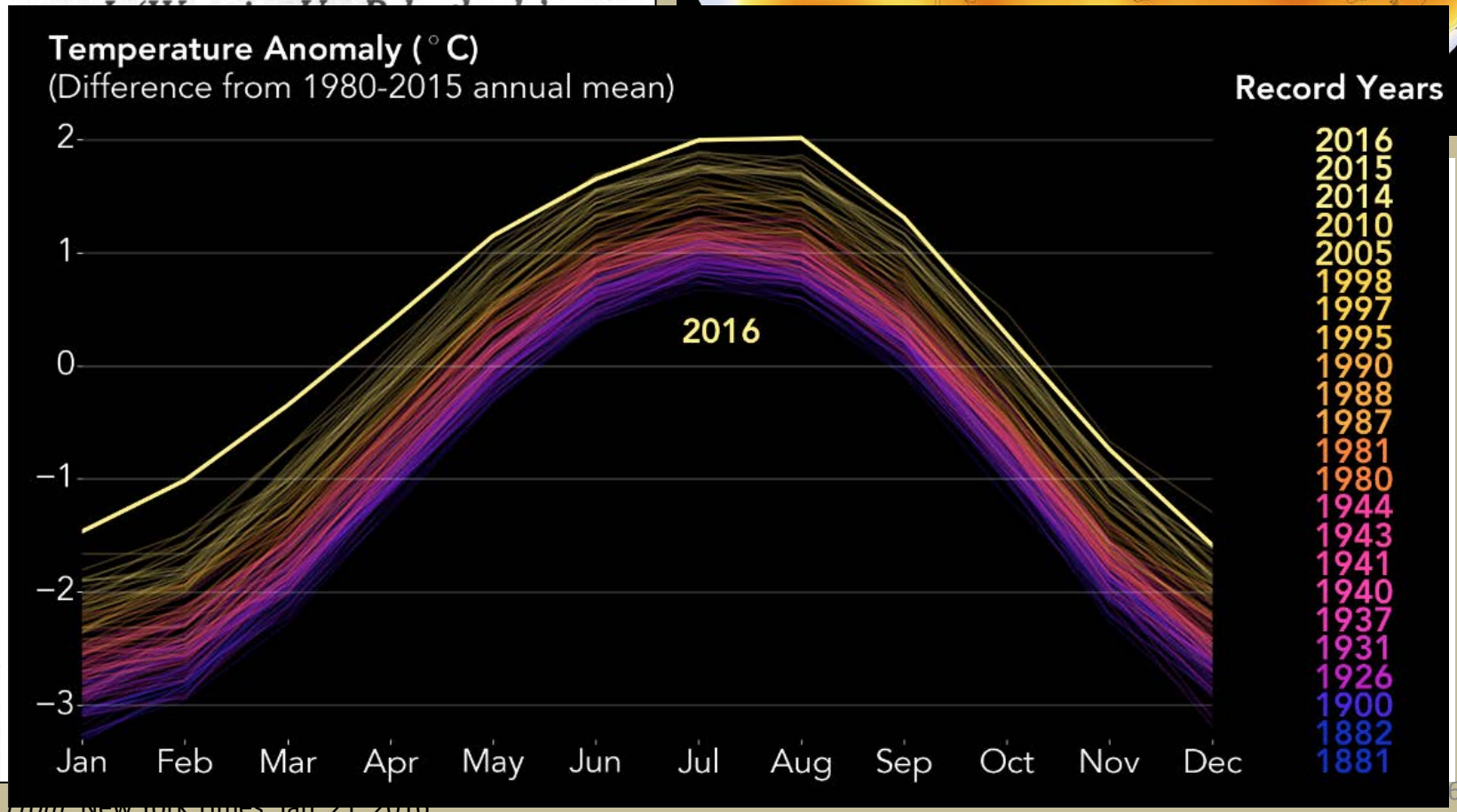
University of California Cooperative Extension

University of California

2015 Far Eclipsed 2014 As World's Hottest Year, Climate Scientists Say

Global Warming Blamed for System That

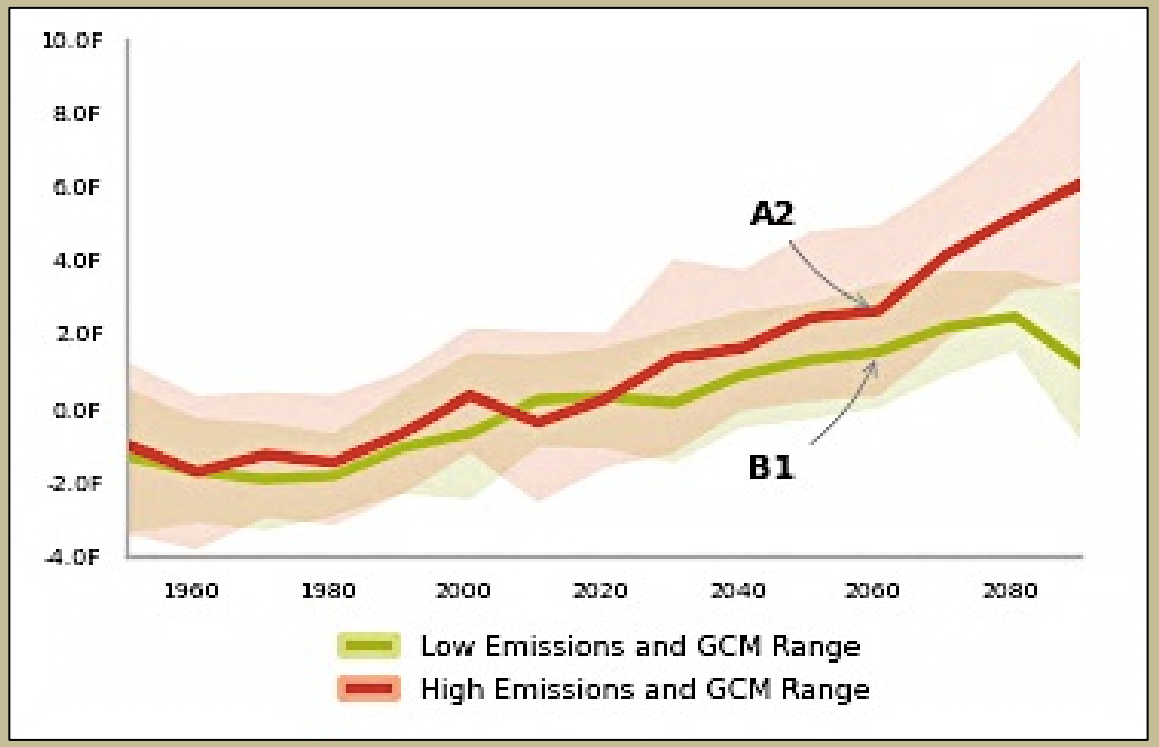




From: New York Times, Jan. 21, 2016

Problem Facing California' Urban Forests

Increasing Temperature



from: Cal-adapt.org

Palo Alto, CA

July Ave. Max. Temperature (°F)

Historic	Predicted
78°	86°

Heat Injury

Oak

Maple

from: Michigan State University Extension (msue.anr.msu.edu)

Objective

To identify tree species in California cities that are not expected to survive as the climate becomes warmer.

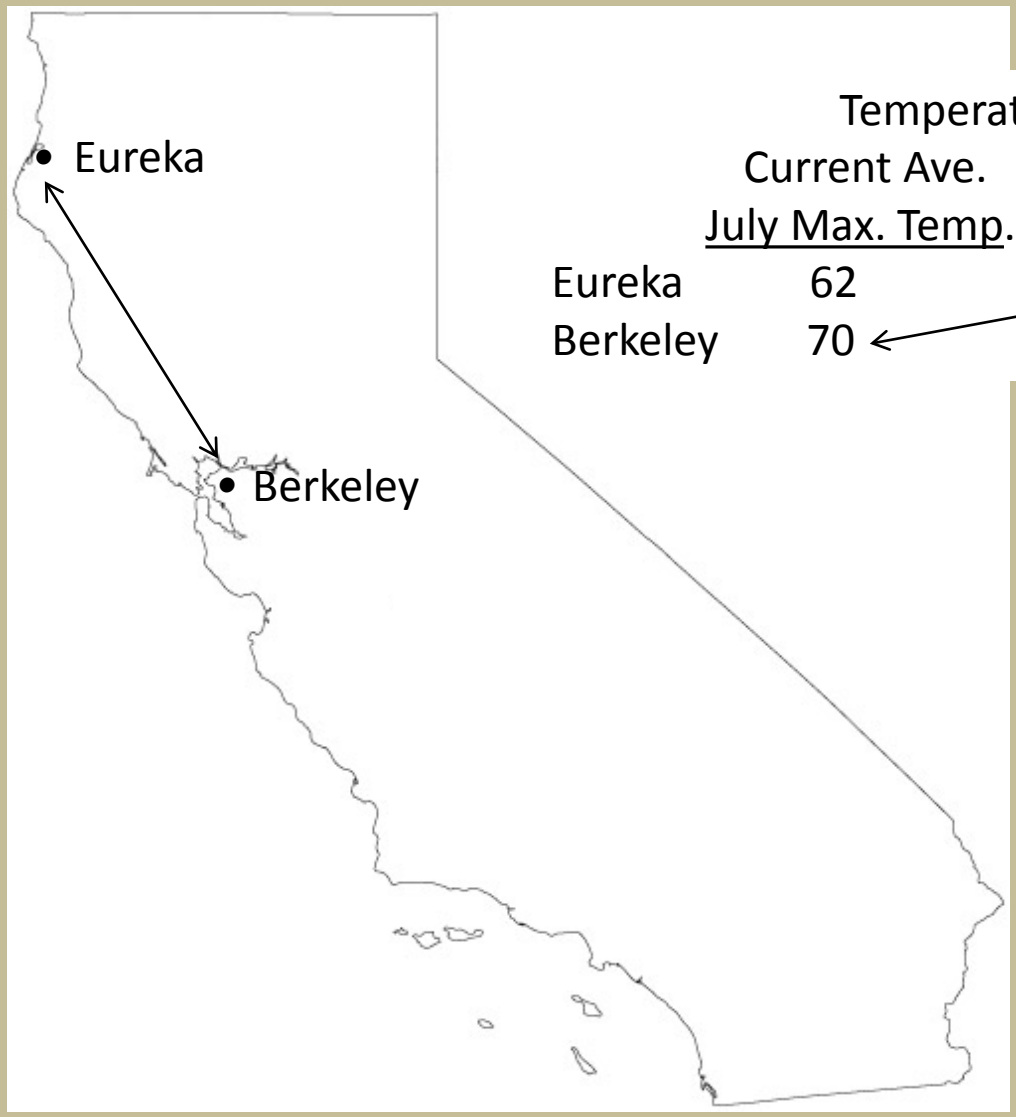
Method

Compare tree species composition
of “example” cities in each climatic zones of California
to the species composition
of cities that are currently as warm as the
example cities will be in 2100 (“warm cities”).

If any “example” city tree species
is currently absent from the “warm” city,
we shall conclude that it will not survive in the
“example” city as the climate becomes warmer.

Example: Eureka

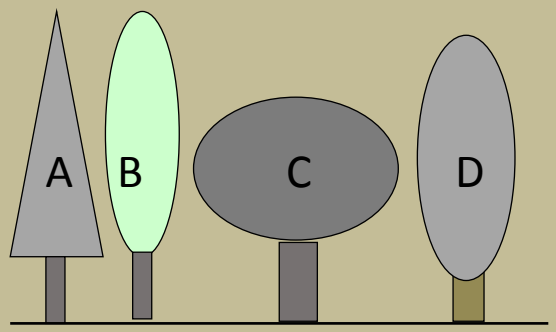
"substituting space for time"



Temperature ^{o}F

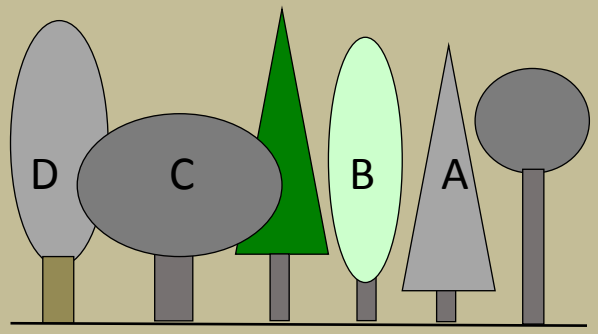
	Current Ave. July Max. Temp.	Predicted Ave. July Max.
Eureka	62	70
Berkeley	70	

Urban Forest Composition



Eureka

"Example" city for Zone 1



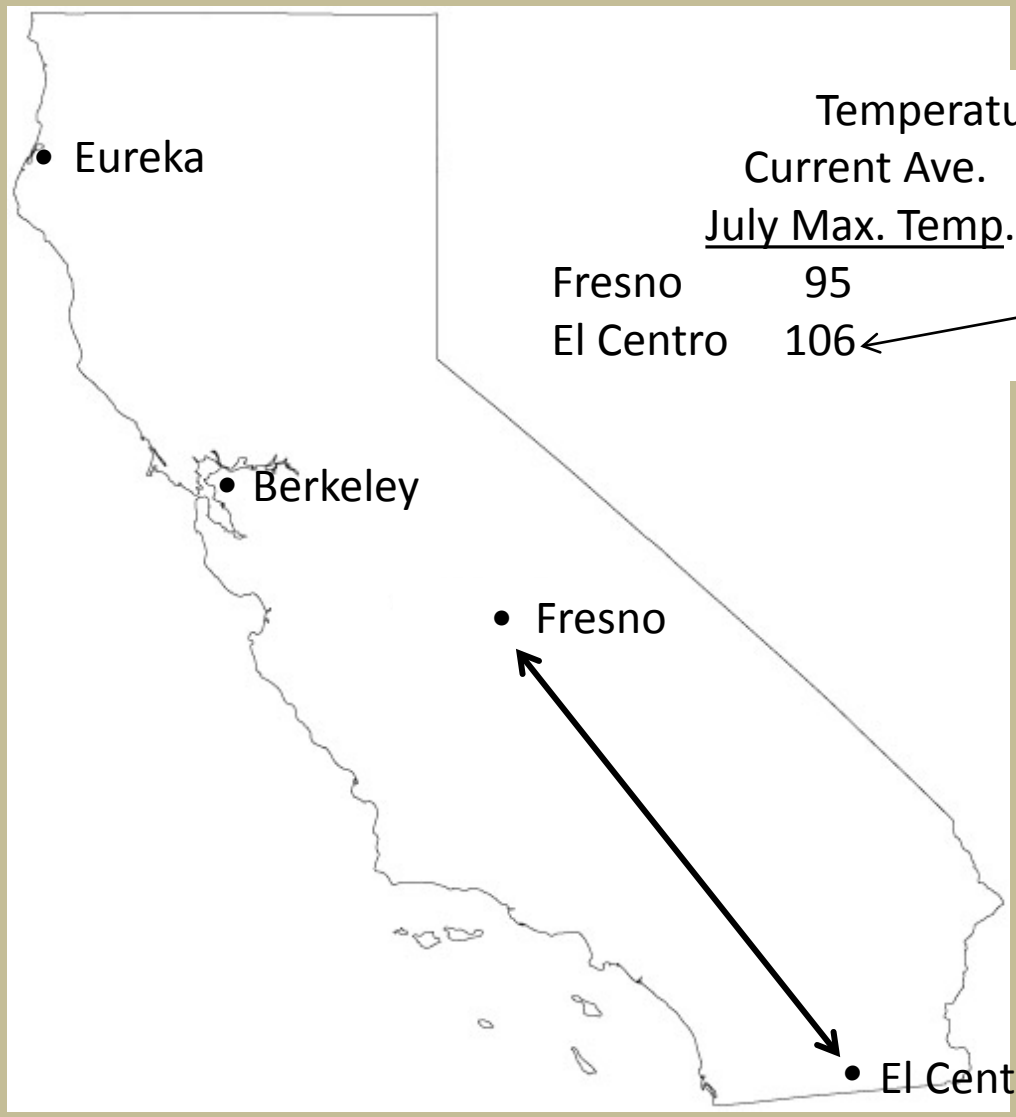
Berkeley

"Warm" city

Conclusion: Street trees in Eureka will survive and perform well as the temperature becomes warmer.

Example: Fresno

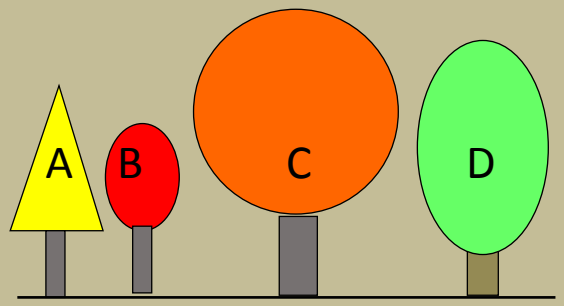
"substituting space for time"



Temperature ^{o}F

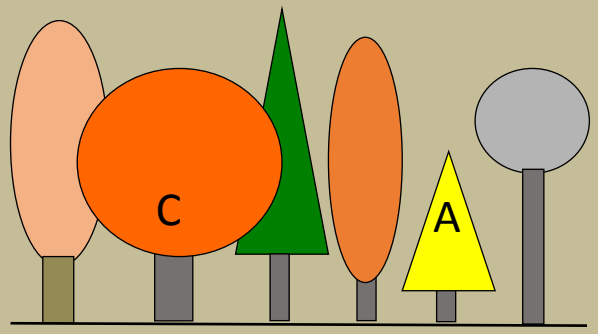
	Current Ave. July Max. Temp.	Predicted Ave. July Max.
Fresno	95	108
El Centro	106	

Urban Forest Composition



Fresno

Example city for Zone 13

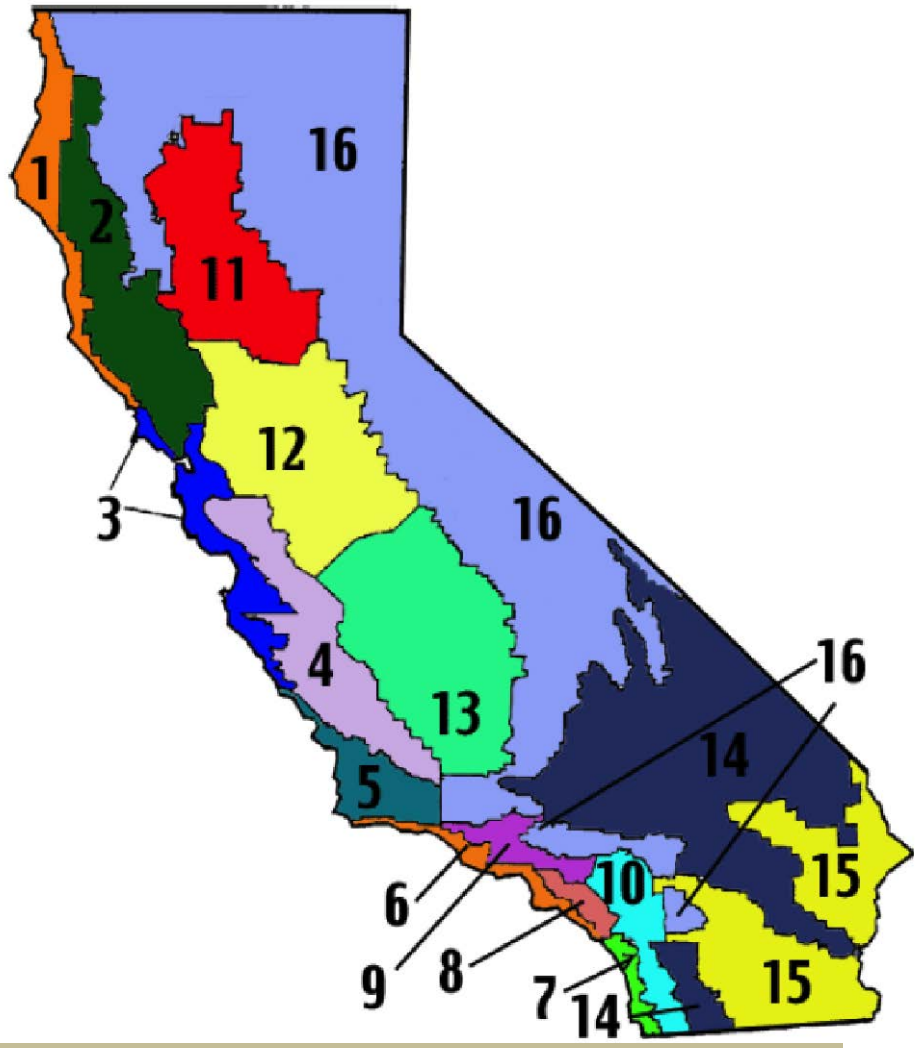


El Centro

"Warm" city

Conclusion: Two of the common street trees in Fresno (B, D) will not survive as the temperature becomes warmer.

Cities Selected as Example Cities



Climate Zone	Example City
1	Eureka
2	Ukiah
3	Berkeley
4	King City
5	Santa Maria
6	Santa Monica
7	San Diego
8	Santa Ana
9	Burbank
10	Riverside
11	Yuba City
12	Stockton
13	Fresno
14	Barstow
15	El Centro
16	Susanville

Historic and Predicted July Average Maximum Temperatures

Climate Zone	Example City	Historic July Ave. Maximum Temp. (°F)	Predicted July Ave. Maximum Temp. (°F)
1	Eureka	61.9	68.9
2	Ukiah	89.7	96.2
3	Berkeley	70.3	80.4
4	King City	85.7	93.7
5	Santa Maria	76.3	80.4
6	Santa Monica	70.5	82.0
7	San Diego	74.0	83.8
8	Santa Ana	82.3	86.9
9	Burbank	86.2	95.2
10	Riverside	91.9	100.8
11	Yuba City	93.5	106.7
12	Stockton	90.4	101.7
13	Fresno	95.4	107.9
14	Barstow	99.5	112.5
15	El Centro	106.0	115.6
16	Susanville	88.7	97.7

from: http://cal-adapt.org/temperature/annual/

Example City and “Warm” Cities

Climate Zone	Example City	“Warm” City
1	Eureka	Berkeley
2	Ukiah	Fresno
3	Berkeley	Santa Ana
4	King City	Stockton
5	Santa Maria	Santa Ana
6	Santa Monica	King City
7	San Diego	Santa Ana
8	Santa Ana	Burbank
9	Burbank	Fresno
10	Riverside	Barstow
11	Yuba City	El Centro
12	Stockton	Barstow
13	Fresno	El Centro
14	Barstow	El Centro
15	El Centro	Furnace Creek
16	Susanville	Barstow

Number of Tree Species

Climate Zone	Example City	Number of Species
1	Eureka	56
2	Ukiah	85
3	Berkeley	71
4	King City	55
5	Santa Maria	49
6	Santa Monica	68
7	San Diego	63
8	Santa Ana	42
9	Burbank	47
10	Riverside	62
11	Yuba City	79
12	Stockton	65
13	Fresno	57
14	Barstow	31
15	El Centro	28
16	Susanville	57

Most Common Species in the Example Cities

Purple Leaf Plum

London Plane Tree

Sweetgum

London Plane Tree

Southern Magnolia

Moreton Bay Fig

Mexican Fan Palm

London Plane Tree

Crape Myrtle

Mexican Fan Palm

Redwood

London Plane Tree

Crape Myrtle

White Mulberry

Silver Wattle

Siberian Elm

Common Eureka Street Trees and their Occurrence in Berkeley

Common Name	Example City Zone #1	Warm City
	Eureka	Berkeley
Apple	+	+
Coast redwood	+	+
Crabapple	+	+
Dragon Tree	+	+
English holly	+	+
European White Birch	+	+
Japanese flowering cherry	+	+
Monterey cypress	+	+
Oregon ash	+	+
Purple leaf Plum	+	+
Southern Magnolia	+	+
Victorian box	+	+

Conclusion

The common street trees in Eureka will survive and perform well as the climate becomes warmer

Apple

Redwood

Crab Apple

Dragon Tree

English Holly

European White Birch

Japanese Flowering

Monterey Cypress

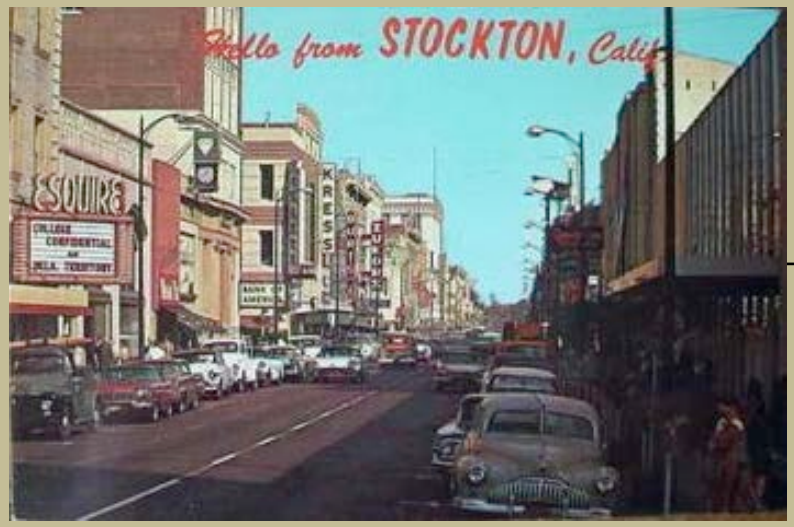
Oregon Ash

Purple Leaf Plum

Southern Magnolia

Climate Zone 12

Example City = Stockton; “Warm” City = Barstow



	July Average Max. Temp (°F)	
City	Historic	Predicted
Stockton	90.4	101.7
Barstow	99.5	112.5

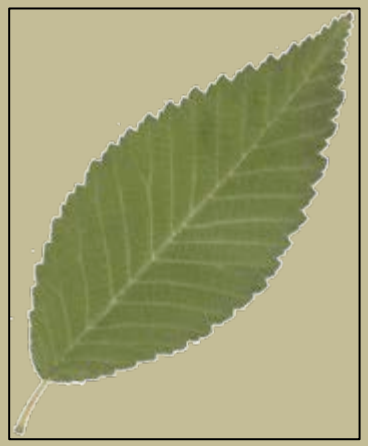
Common Stockton street trees and their occurrence in Barstow and warmer cities

Common Name	Example City Zone #12	Warm City	Warmer Cities	
	Stockton	Barstow	El Centro	Furnace Creek
Bradford pear	+	-	-	-
Chinese elm	+	+	-	-
Chinese pistache	+	+	-	-
Common Hackberry	+	-	-	-
Crape myrtle	+	+	-	-
Evergreen ash	+	+	-	-
London plane tree	+	-	-	-
Modesto ash	+	+	+	-
Purple leaf plum	+	+	-	-
Sweetgum	+	-	-	-

Conclusion

Four of the common street trees in Stockton will not survive as the climate becomes warmer

Bradford Pear



Chinese Elm

Chinese Pistache

Common Hackberry

Crape Myrtle

Evergreen Ash

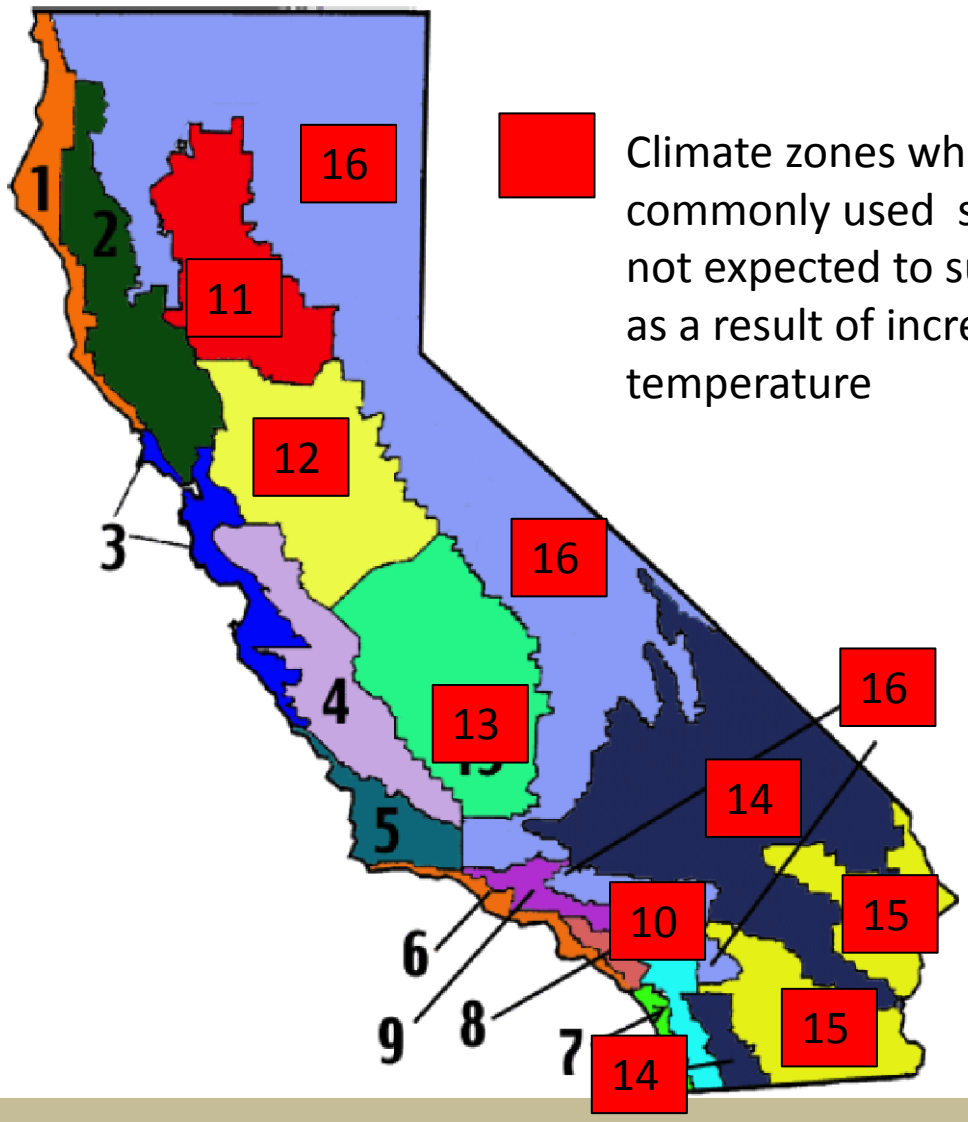
London Plane Tree

Modesto Ash

Purple leaf plum

Sweetgum

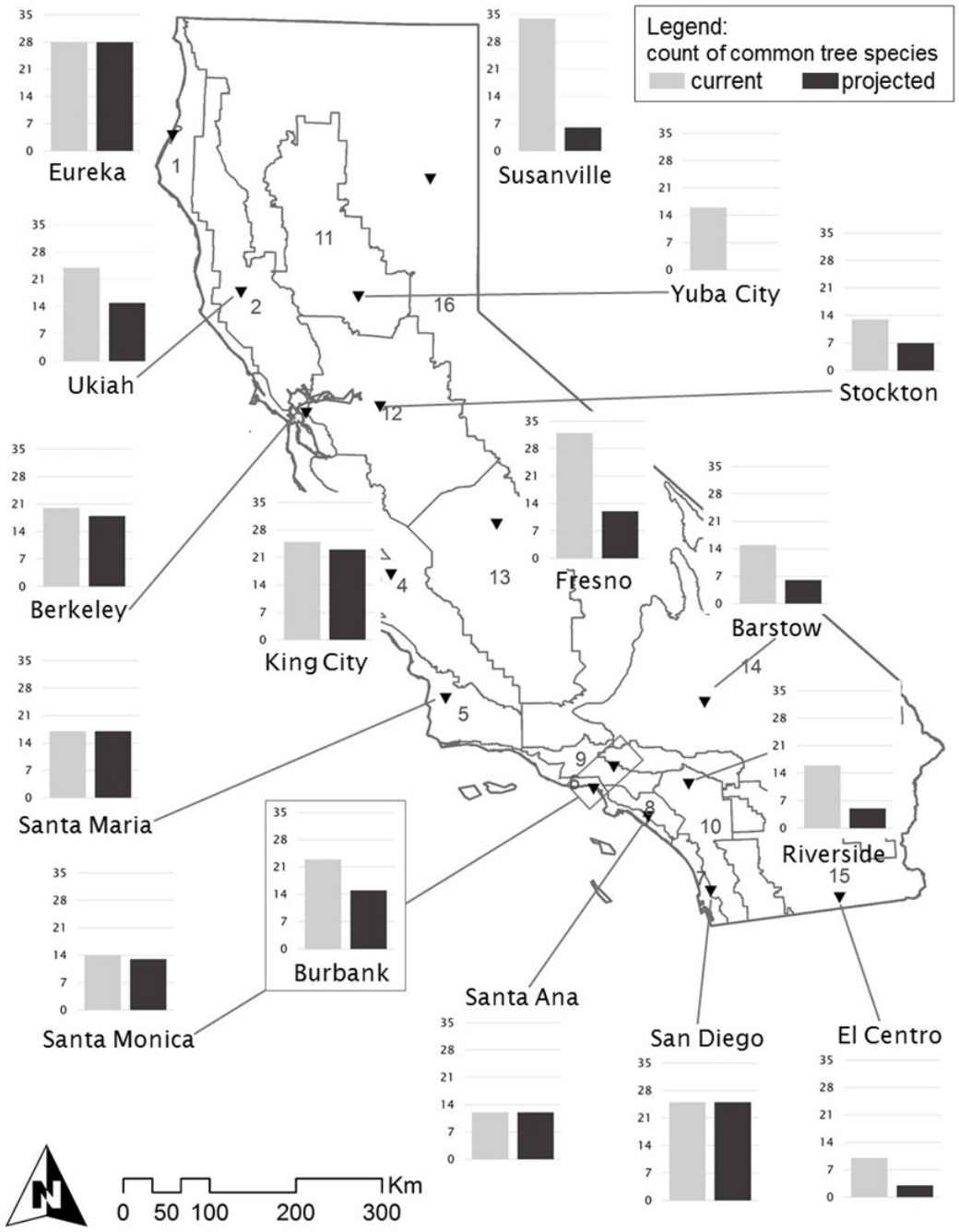
California Climate Zones



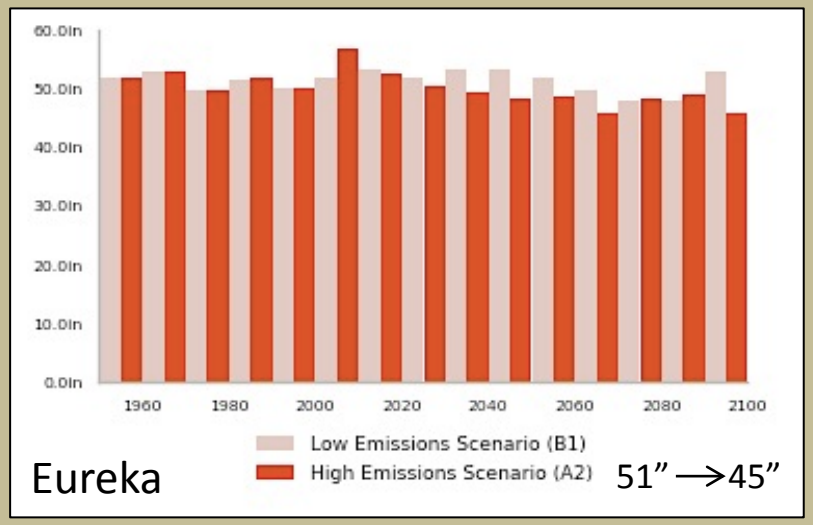
Climate zones where some commonly used street trees are not expected to survive as a result of increasing temperature

Climate Zone	Example City
1	Eureka
2	Ukiah
3	Berkeley
4	King City
5	Santa Maria
6	Santa Monica
7	San Diego
8	Santa Ana
9	Burbank
10	Riverside
11	Yuba City
12	Stockton
13	Fresno
14	Barstow
15	El Centro
16	Susanville

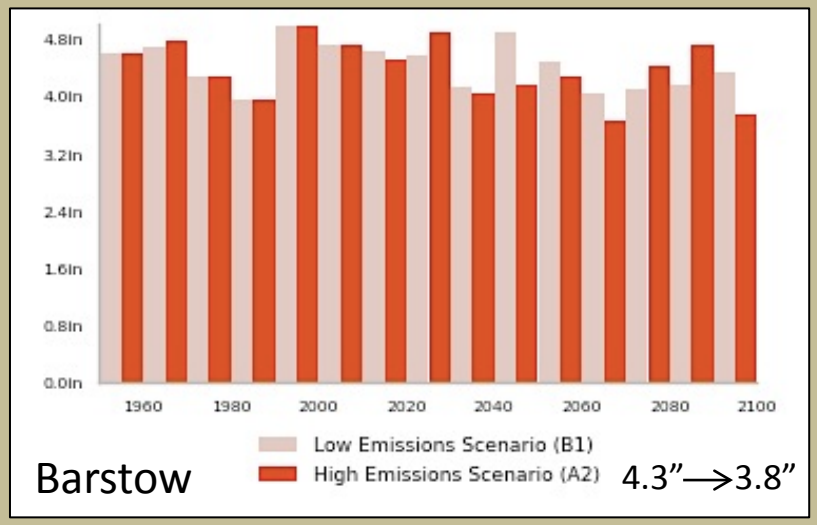
results


Legend:
count of common tree species
current
projected
Eureka
Susanville
Yuba City
Ukiah
Stockton
Berkeley
Fresno
King City
Barstow
Santa Maria
Riverside
Burbank
Santa Monica
Santa Ana
San Diego
El Centro
1
2
11
16
12
4
13
14
5
9
8
10
15
N
0 50 100 200 300
Km

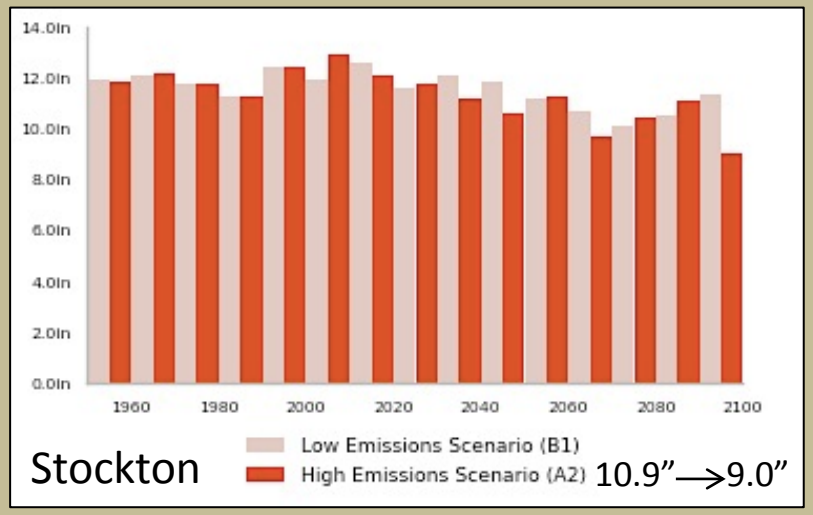
Change in Precipitation



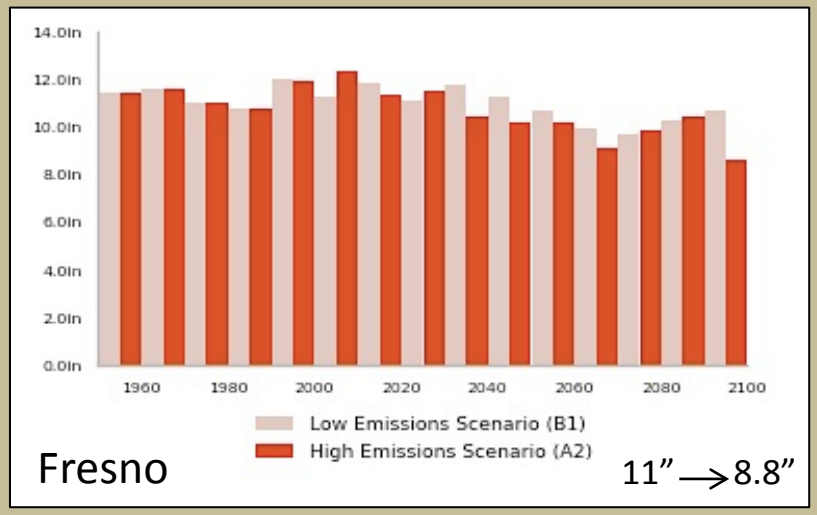
Eureka 51” → 45”



Barstow 4.3” → 3.8”



Stockton 10.9” → 9.0”



Fresno 11” → 8.8”

from: Cal-adapt.org

Common Street Tree Species - Stockton

Bradford Pear

IR[1]: M

DT[2]: M-D

Chinese Elm

IR[1]: M/L

DT[2]: DT

Chinese Pistache

IR[1]: M/L

DT[2]: DT

Common Hackberry

IR[1]: M/L

DT[2]: DT

Crape Myrtle

IR[1]: M/L

DT[2]: DT

Evergreen Ash

IR[1]: M

DT[2]: M-D

London Plane Tree

IR[1]: M/H

DT[2]: W-D

Modesto Ash

IR[1]: M

DT[2]: M-D

Purple-leaf Plum

IR[1]: M

DT[2]: M

Sweetgum

IR[1]: M

DT[2]: W-D

[1] Irrigation Requirement: M/H = medium to high, M = medium, M/L = medium to low

[2] Soil Moisture Tolerance or Drought Tolerance: M-D = moist to dry soil, W-D = wet to dry, M = moist soil, DT = drought tolerant

Street Tree Species not in “Warm’ or Warmer” Cities

Bradford Pear

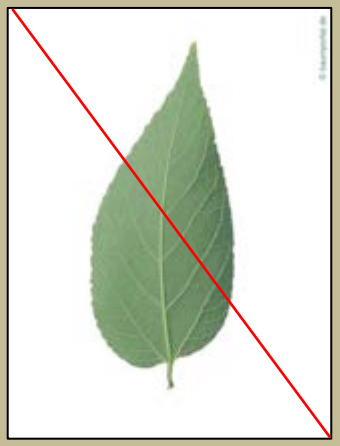
IR[1]: M
DT[2]: M-D

Chinese Elm

IR[1]: M/L
DT[2]: DT

Chinese Pistache

IR[1]: M/L
DT[2]: DT



Common Hackberry

IR[1]: M/L
DT[2]: DT

Crape Myrtle

IR[1]: M/L
DT[2]: DT

Evergreen Ash

IR[1]: M
DT[2]: M-D

London Plane Tree

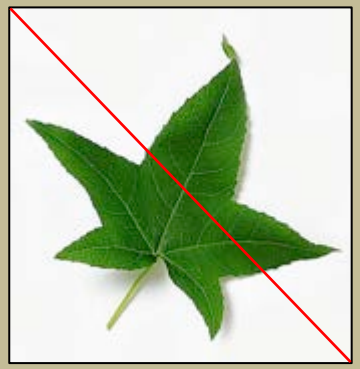
IR[1]: M/H
DT[2]: W-D

Modesto Ash

IR[1]: M
DT[2]: M-D

Purple-leaf Plum

IR[1]: M
DT[2]: M



Sweetgum

IR[1]: M
DT[2]: W-D

[1] Irrigation Requirement: M/H = medium to high, M = medium, M/L = medium to low

[2] Soil Moisture Tolerance or Drought Tolerance: M-D = moist to dry soil, W-D = wet to dry, M = moist soil, DT = drought tolerant

Irrigation Requirement and Drought Tolerance

Bradford Pear

IR[1]: M
DT[2]: M-D

Chinese Elm

M/L
DT

Chinese Pistache

M/L
DT

Common Hackberry

M/L
DT

Crape Myrtle

M/L
DT

Evergreen Ash

IR[1]: M
DT[2]: M-D

London Plane Tree

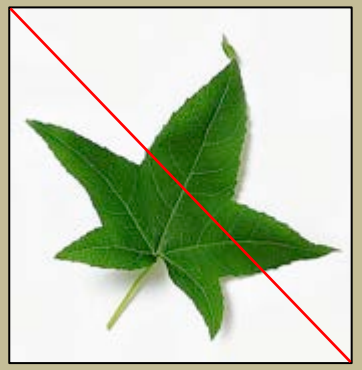
M/H
W-D

Modesto Ash

M
M-D

Purple-leaf Plum

M
M



Sweetgum

M
W-D

[1] Irrigation Requirement: M/H = medium to high, M = medium, M/L = medium to low

[2] Soil Moisture Tolerance or Drought Tolerance: M-D = moist to dry soil, W-D = wet to dry, M = moist soil, DT = drought tolerant

Consequence of Climate Change:
Some currently used trees will not survive or not perform well

outline

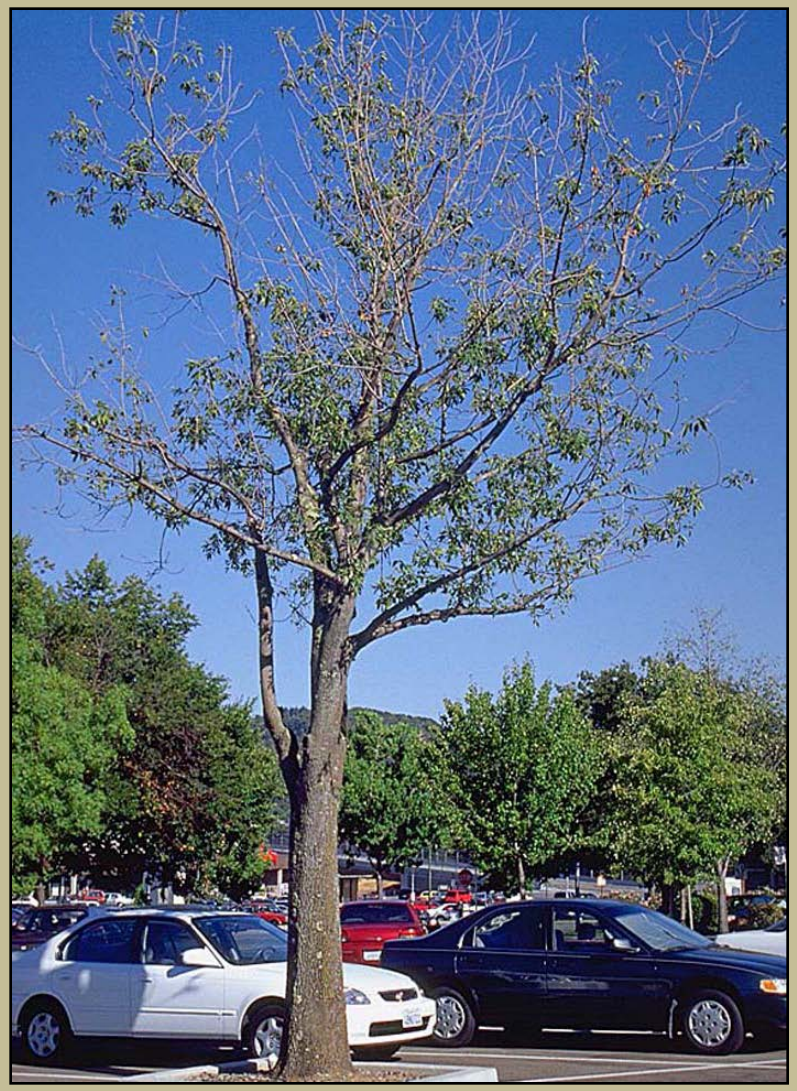
We are discussing ornamental trees in residential landscapes;
NOT wildlands forests, timber plantations, agriculture, orchards!

1. *Street trees & climate change study: what we can learn from space-for-time substitution*
2. *…what do the study results suggest for individual landscapes*
3. *…and how to establish your trees and maintain them during the drought*

warmer, maybe drier on average… so…

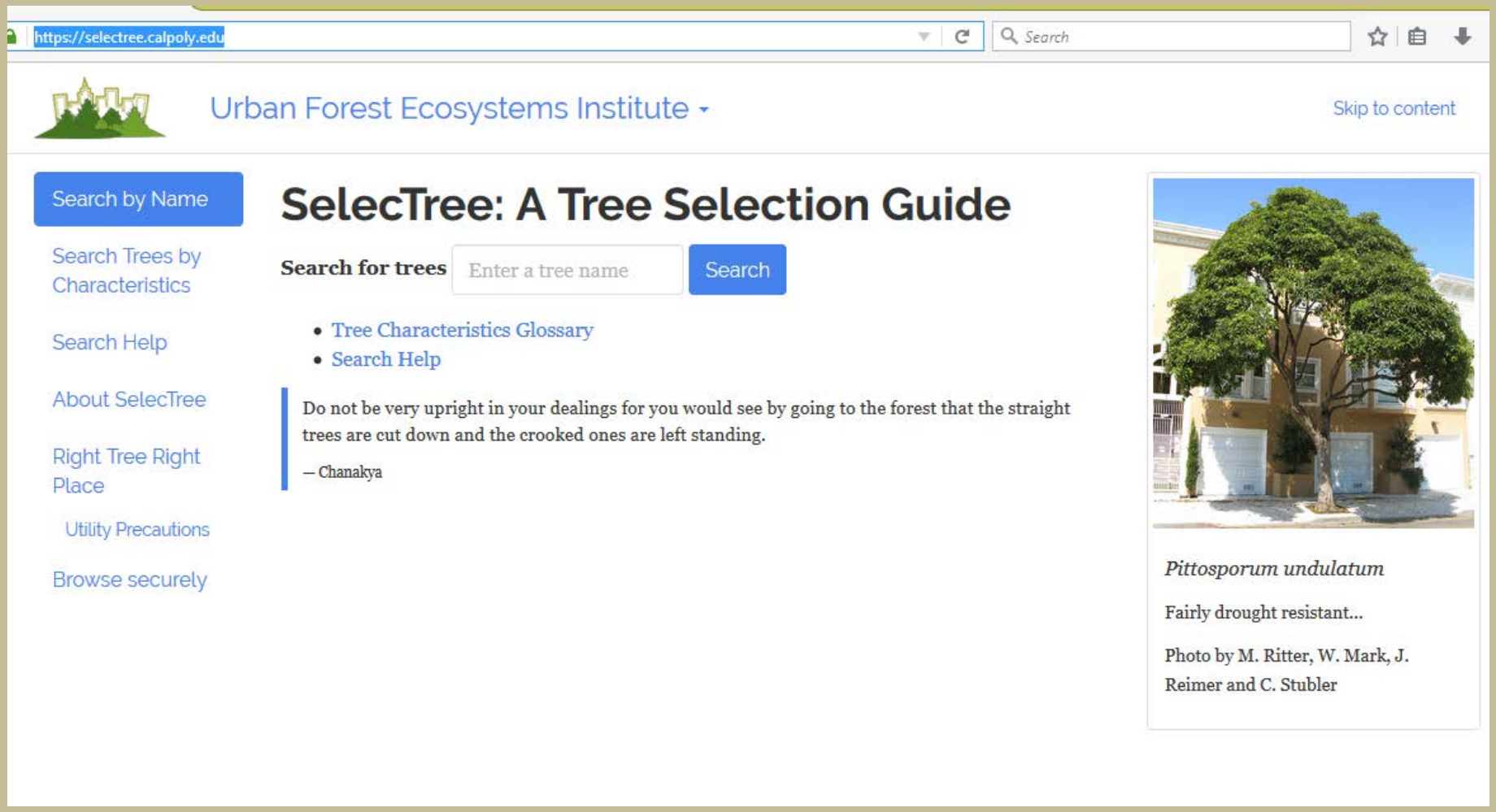
assess **your tree's** *environment →*	*~ reflective surfaces? Paving?* *~ sandy/rocky soils? slope?* *~ etc. (you know this!)*
evaluate your tree's climate envelope →	*~ is it "at the edge" now?* *~ our study* *~ SelecTree*
consider the major landscape pests →	*~ UC IPM website* *~ Pest Vulnerability Matrix (PVM)*
understand **and meet** *your tree's water needs →*	*~ WUCOLS* *~ calculate!* *~ apply properly*

Landscape Situations that favor Water Deficits…



yes, I know your landscape probably differs from these…

https://selectree.calpoly.edu/

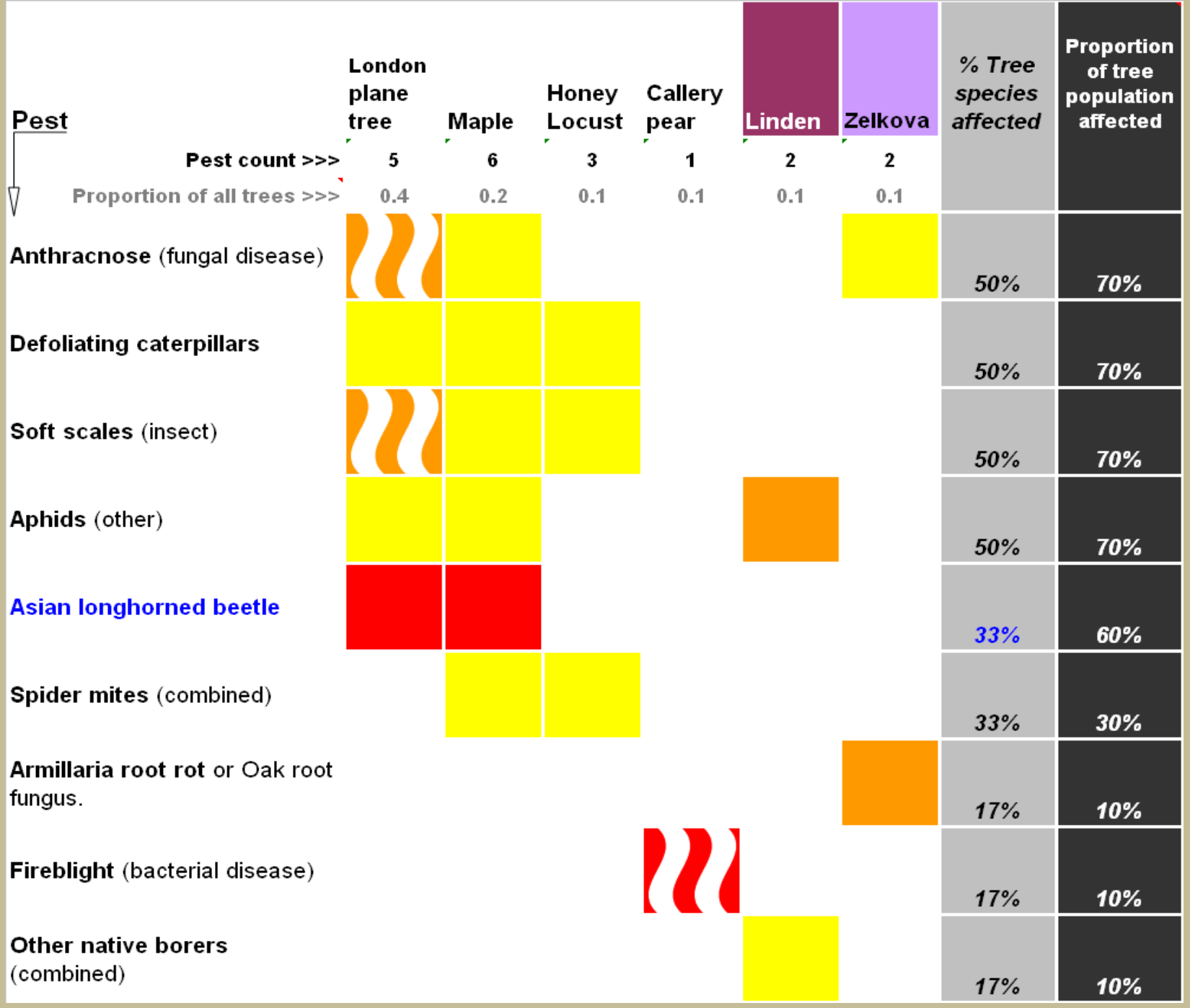


~ you can search for a species by desired characteristics!

Species not expected to perform well – based on “warm” or “warmer” city

Climate Zone: / Species	10 Riverside	11 Yuba City	12 Stockton	13 Fresno	14 Barstow	15 El Centro	16 Susanville
Allepo pine					•		
Apple							•
Australian willow						•	
Black Cottonwood							•
Bradford pear			•	•			
Canary Island pine	•			•			
Chinaberry					•		
Chinese elm				•	•		
Chinese Pistache		•		•			
Common Hackberry			•				
Crape Myrtle				•			
Darlington oak				•			
Deodar cedar				•			
Evergreen ash			•				
Fern pine				•			
Gingko				•			
Golden chain trees	•						
Honey Locust							•
Indian laurel fig						•	
Lemon scented gum						•	
London plane tree	•	•					
Modesto ash						•	
Norway Spruce							•
Orange	•						
Purple leaf plum		•		•			
Raywood Ash	•			•			
Redwood		•					
Siberian elm						•	
Silver dollar eucalyptus						•	
Silver wattle						•	
Southern Magnolia	•	•					
Sweetgum		•	•	•			
White Mulberry		•			•		

http://ipm.ucanr.edu/


Pest
London plane tree
Maple
Honey Locust
Callery pear
Linden
Zelkova
% Tree species affected
Proportion of tree population affected
Pest count >>>
5
6
3
1
2
2
Proportion of all trees >>>
0.4
0.2
0.1
0.1
0.1
0.1
Anthracnose (fungal disease)
50%
70%
Defoliating caterpillars
50%
70%
Soft scales (insect)
50%
70%
Aphids (other)
50%
70%
Asian longhorned beetle
33%
60%
Spider mites (combined)
33%
30%
Armillaria root rot or Oak root fungus.
17%
10%
Fireblight (bacterial disease)
17%
10%
Other native borers (combined)
17%
10%

PVM

outline

We are discussing ornamental trees in residential landscapes;
NOT wildlands forests, timber plantations, agriculture, orchards!

1. *Street trees & climate change study: what we can learn from space-for-time substitution*
2. *…what do the study results suggest for individual landscapes*
3. *…and how to establish your trees and maintain them during the drought*

Young trees: *Lack of water = quick death*

←*Problem: what does "Deep watering" mean here?*

(how much can it hold?)

"Crispy critters" (Larry Costello) →

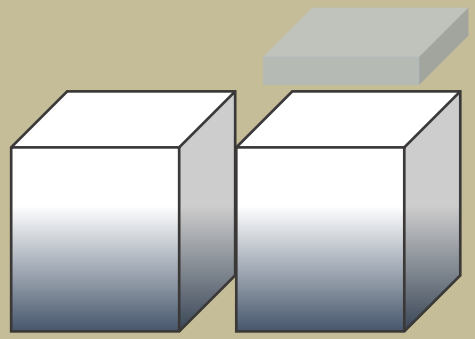
Young tree solutions

How much?
Amazingly little: 5-10 gal

How often?
Frequently! (X times/WEEK)

Who?
Residents
NGOs
Partners (schools, churches, business)

Mature trees: *Functional irrigation approach, or refilling the "water reservoir"*
(Nelda Matheny and Larry Costello)



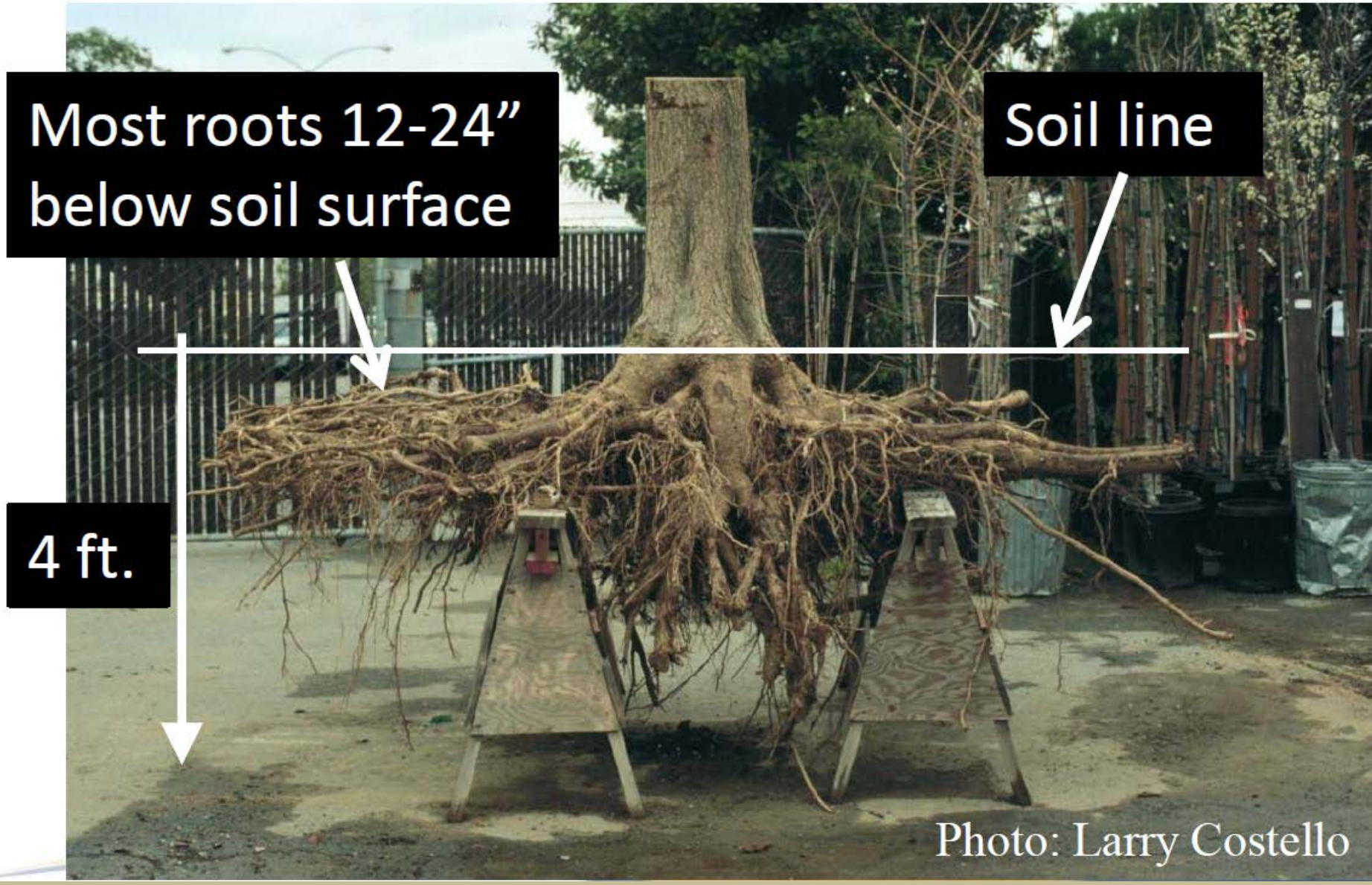
1 in on 1 ft² = 0.62 gal.

Soil water reservoir capacity: 2 elements

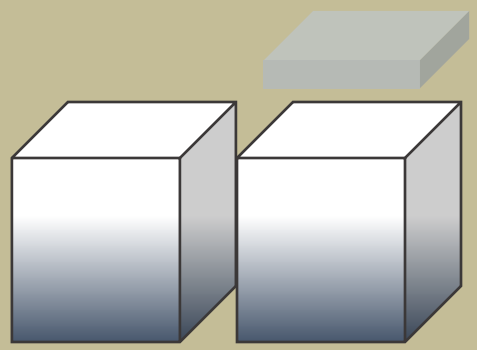
*Volume → area*depth, or inches water/foot depth*

Texture → available water → loam > clay > sand

Soil water reservoir: Where are the roots?



Functional irrigation approach for mature trees: estimating the size of the “water reservoir”



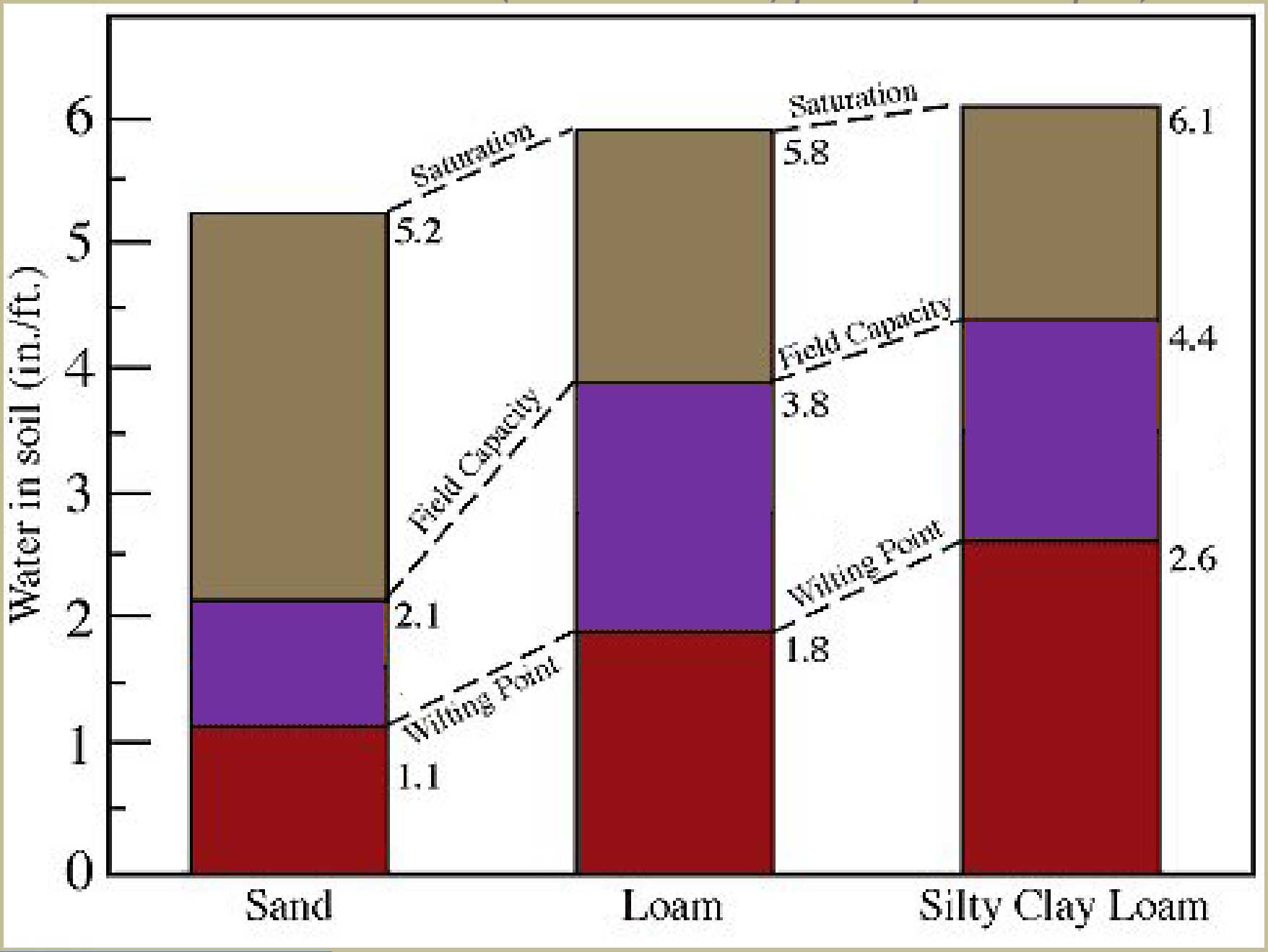
1 in on 1 sq ft
= 0.62 gal.

Soil water reservoir capacity: 2 elements

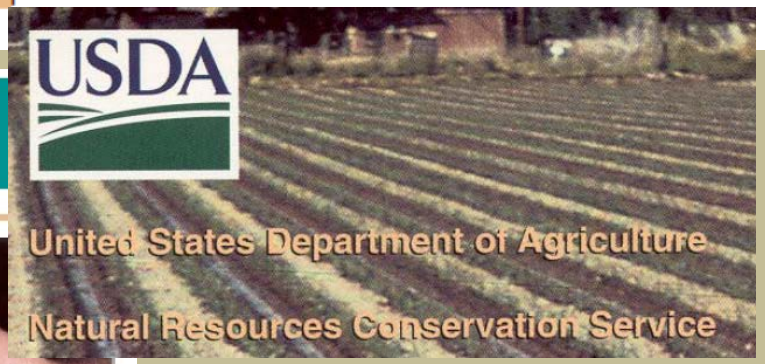
Volume → *area*depth, or inches water/foot depth*

Texture → *water stored→ clay > loam >> sand*
water available → sand > loam > clay)

Available *water in soils (inches water/foot of soil depth)*



Estimating Soil Moisture by Feel and Appearance



Appearance of clay, clay loam, and silt clay loam soils at various soil moisture conditions.

Available WaterCapacity
1.6-2.4 inches/foot

Percent Available: Currently available soil moisture as a percent of available water capacity.

In/ft. Depleted: Inches of water currently needed to refill a foot of soil to field capacity.

0-25 percent available
2.4-1.2 in/ft. depleted

Dry, soil aggregations separate easily, clods are hard to crumble with applied pressure. (Not pictured)

50 - 75 percent available
1.2-0.4 in./ft. depleted

Moist, forms a smooth ball with defined finger marks, light soil/water staining on fingers, ribbons between thumb and forefinger.

Mature tree solutions

How much?
Substantial: 100 to 100s of gal.

How often?
Seldom! (X times/SUMMER)

Who?
Residents
Municipalities
Partners (schools, churches, business)

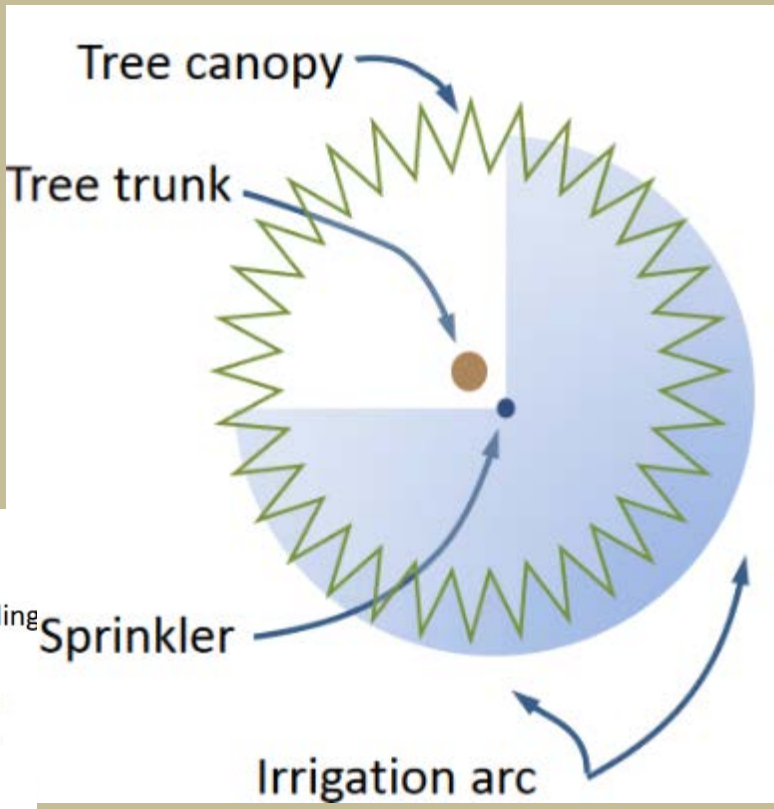
Oki/Fujino RSIC→

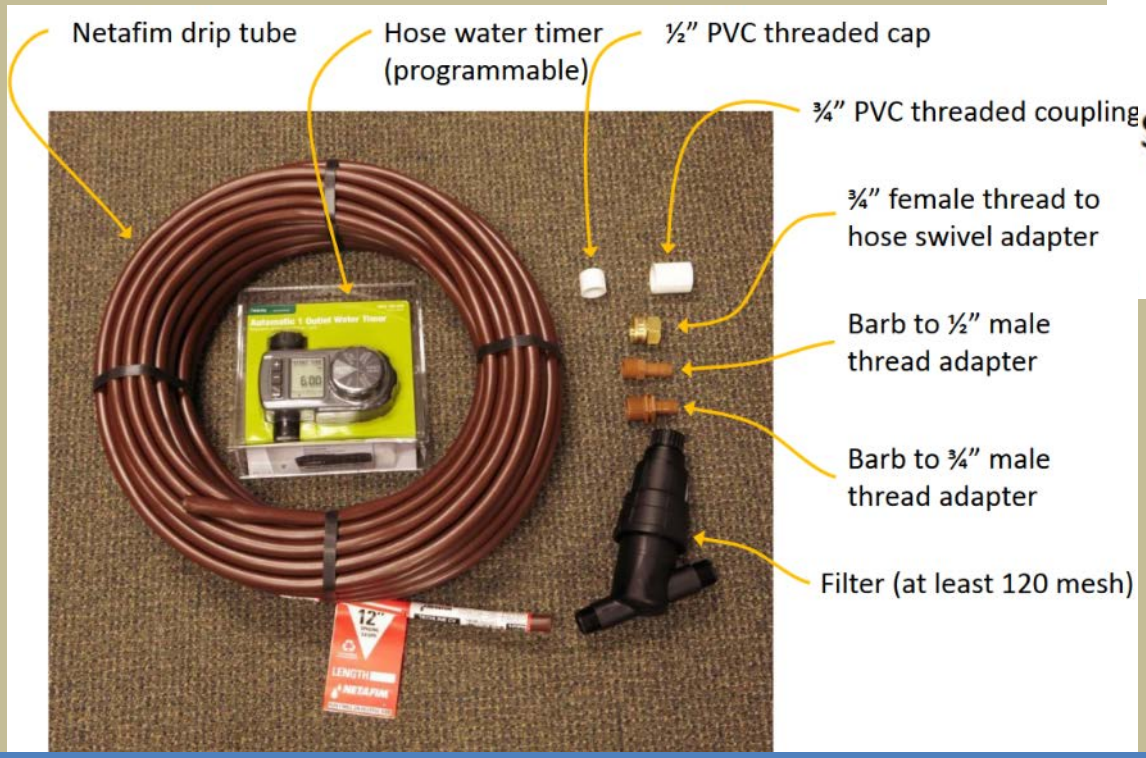
and

TRIC ↓

Mature tree solutions: **ccuh.ucdavis.edu**

The challenge:
How to apply water
~~*too much, too little*~~
without runoff





↑RSIC

and

← TRIC

Tree canopy

Radius= 6 ft

Circumference= 37.7 ft

1. Enter the radius of the tree canopy

This calculator should not be used for trees with canopies with radii less than 4 ft.

Drip tubing

Use 100 ft. lengths of Netafim CV drip line with 0.6 gph emitters with 12" spacing

1

2. Enter how many 100' lengths of drip line are used

Flow rate= 60.8 gph

1

Recommended number of lengths

For the radius of 6 feet, you will need 113 feet of drip tube.

There should be 1 foot between the circles of drip tube around the tree. The 1 length will be long enough to make nearly four circles of drip tube around the tree and will be sufficient.

Start laying the drip tube about 1 foot outside of the drip line of the tree canopy.

Irrigation

Precip rate= 0.98 in/hr

Soil texture

silty clay

3. Click on the green cell to the left to see different soil textures

Then, select your soil texture from the drop down list

Duration*

*To wet to 36 inches deep

4. This is the run time required to wet the soil to 36 inches.

2:35 hours:minutes

Fujino/Oki TRIC Calculator

Example: **silty clay**

Compare my trees' water use to other species:

ucanr.edu/sites/Wucols

ucanr.edu/sites/WUCOLS/

SHARE | EMAIL | PRINT | SITE MAP | Enter Search Terms

WUCOLS IV

Water Use Classification of Landscape Species

- **Home Page**
- User Manual
- Plant Search Instructions
- Plant Search Database
- Download WUCOLS IV Plant List
- Download WUCOLS IV User Manual
- Water Requirements for Turfgrasses
- Partners
- Acknowledgements

Home Page

GETTING STARTED

If you are using the WUCOLS list for the first time, it is essential that you read the *User Manual*. The manual contains very important information regarding the evaluation process, categories of water needs, plant types, and climatic regions. It is necessary to know this information to use WUCOLS evaluations and the plant search tool appropriately. To access the *User Manual*, click on the tab (on left) and view specific topics.

Water conservation is an essential consideration in the design and management of California landscapes. Effective strategies that increase water use efficiency must be identified and implemented. One key strategy to increase efficiency is

UC CE

WUCOLS categories

CATEGORIES OF WATER NEEDS

Category	Abbreviation	Percentage of ET_o
High	H	70–90
Moderate	M	40–60
Low	L	10–30
Very Low	VL	< 10

Fig. 2. Five-finger fern was assigned to the "high" water needs category in four regions.

ucanr.edu/sites/UrbanHort

UC CE

basic ideas

warmer climate = challenge to trees and to management		*but we still will be able to grow trees*
mortality is unfortunate but normal		*not an excuse for not (re)planting!*
What are the factor(s) in tree loss (which you can manage?)		*species selection? site conditions? management?*
droughts will recur, perhaps more frequently		*help your trees survive!*


Thank you!
Igor Lać an
ilacan@ucanr.edu
510 684 4323
UC
CE
University of California
Agriculture and Natural Resources
Cooperative Extension